APPARATUS, SYSTEM AND METHOD FOR SUBSCRIPTION COMPUTING USING SPARE RESOURCES OF SUBSCRIBER COMPUTING PLATFORMS

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention is directed to an apparatus, system and method for subscription computing using spare resources of subscriber computing platforms.

2. Description of Related Art:

Information Technology (IT) outsourcing, or subscription computing, is a package of hardware, system and application software, services and support providing a complete implementation of a computing infrastructure. Personal computers, local area networks, an optional local server, a gateway, and Internet service are all examples of hardware, software and services that are provided to a subscription computing subscriber. Telephone-based support with remote-access software is often provided to subscription computing subscribers to resolve subscriber problems. In addition, anti-virus and data backup services may be offered to guard the subscriber's data. Such subscription computing services are often utilized by small businesses, for example, which are charged a monthly fee for the provided service.

With known IT outsourcing or subscription computing systems, the subscription computing services are provided centrally. That is, all subscription computing services, such as data backup, data analysis, and the like, make use of resources of the subscription service provider. Because these services are provided centrally, the central hosting cannot scale beyond a certain point because the service provider is a central point of failure in the system and is vulnerable to network outages. Therefore, it would be beneficial to have an apparatus, system and method for providing subscription computing services that overcomes the vulnerability of the centrally provided subscription computing services of the prior art.

SUMMARY OF THE INVENTION

The present invention provides an apparatus, system and method for subscription computing using spare resources of subscriber computing platforms. The present invention provides an apparatus, system, method and business model in which computation and storage intensive tasks of subscription computing are performed with subscriber resources in a peer-to-peer computation model rather than with centralized resources owned by a service provider. Resources may be allocated on unused workstations, workstations not currently in active use, e.g., a screensaver is active, on workstations elsewhere in the enterprise, servers running under capacity provided they participate in the peer computing environment, and the like. Moreover, workstations in the enterprise may be equipped with extra resources for use in providing the subscription computing services of the present invention.

With the present invention, the cost of subscription computing services provisioned by a provider is reduced because the provider no longer has to maintain the resources on which the various services are provisioned. The provider merely maintains control over the services running on subscriber equipment. An additional benefit to the subscriber is that during periods of communication outages between the subscription computing service provider and the subscriber's premises, the subscription computing services can continue to be provided because they are provisioned on the subscriber's premises. Moreover, because the services are provisioned on the subscriber's premises, security issues with regard to subscription services are not an issue. Other features and advantages of the present invention will be described in, or will become apparent to those of ordinary skill in the art in view of, the following detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is an exemplary diagram of a data processing system according to the present invention;

Figure 2 is an exemplary block diagram of a server computing system in accordance with the present invention;

Figure 3 is an exemplary block diagram of a client computing system in accordance with the present invention;

Figure 4 is an exemplary block diagram of a subscription computing service provider according to the present invention;

Figure 5 is an exemplary diagram illustrating an example operation of the present invention; and

Figure 6 is a flowchart outlining an exemplary operation of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention provides an apparatus, system and method for providing subscription computing services in a peer-to-peer manner using resources of subscriber computing platforms. Peer-to-peer infrastructures have been developed for use in swapping data amongst client machines, such as is used by the Gnutella software, and for distributing processing of data across a plurality of client devices, such as in the SETI@home project.

With Gnutella, for example, client devices are paired based on whether a client device contains a file desired by another client device. The first client device may then download the file directly from the second client device without having to first store data on a central site. See the description of Gnutella at http://gnutella.wego.com, which is hereby incorporated by reference.

With the SETI@home project, client devices download a client application that is used as a screensaver. When the screensaver becomes active, data is downloaded from a SETI server and analysis of the data is performed on the client computer using the client application. The results of the analysis are then uploaded to the SETI server. See the description of the SETI@home project available from http://setiathome.ssl.berkeley.edu.

The present invention builds on the peer-to-peer infrastructures provided in the Gnutella and SETI@home systems and makes use of peer-to-peer infrastructure in providing subscription computing services to subscribers using the subscriber's own computing platform resources. The subscription computing service provider of the present invention is preferably provided in a distributed data processing environment such as in a distributed network, such as the Internet. As such, a brief explanation of the distributed data processing environment and computing devices therein will be provided as a context in which the present invention operates.

With reference now to the figures, **Figure 1** depicts a pictorial representation of a network of data processing systems in which the present invention may be

implemented. Network data processing system **100** is a network of computers in which the present invention may be implemented. Network data processing system **100** contains a network **102**, which is the medium used to provide communications links between various devices and computers connected together within network data processing system **100**. Network **102** may include connections, such as wire, wireless communication links, or fiber optic cables.

In the depicted example, server **104** is connected to network **102** along with storage unit **106**. In addition, clients **108**, **110**, and **112** are connected to network **102**. These clients **108**, **110**, and **112** may be, for example, personal computers or network computers. In the depicted example, server **104** provides data, such as boot files, operating system images, and applications to clients **108-112**. Clients **108**, **110**, and **112** are clients to server **104**. Network data processing system **100** may include additional servers, clients, and other devices not shown. In the depicted example, network data processing system **100** is the Internet with network **102** representing a worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another. At the heart of the Internet is a backbone of high-speed data communication lines between major nodes or host computers, consisting of thousands of commercial, government, educational and other computer systems that route data and messages. Of course, network data processing system **100** also may be implemented as a number of different types of networks, such as for example, an intranet, a local area network (LAN), or a wide area network (WAN). **Figure 1** is intended as an example, and not as an architectural limitation for the present invention.

The client devices **108**, **110** and **112**, and the storage device **106** may be part of the same subscriber enterprise, e.g., a subscriber's computing system or network, or may be part of any number of different subscriber enterprises. In one particular embodiment, the present invention uses resources of client devices that are within the same subscriber enterprise, while in another embodiment the present invention can make use of resources of client devices in different subscriber enterprises, as will be described in greater detail hereafter.

The client devices **108**, **110** and **112**, and the storage device **106** are preferably provided with software and/or devices capable of reporting system operating information to a subscription computing service provider. The system operating information reported to the subscription computing service provider is used to control subscription computing services performed using the resources of the client devices **108**, **110** and **112**, and storage device **106**, as will be described in greater detail hereafter.

The server **104** may be used as subscription computing service provider in accordance with the present invention. As a subscription computing service provider, the server **104** controls subscription computing services being performed using the resources of the client devices **108**, **110** and **112**, and storage device **106**. The server **104** receives system operating information from the client devices **108**, **110** and **112**, and storage device **106**. In addition, the server stores subscription computing information identifying the services to be provided to the subscriber. Based on the system operating information and subscription computing information, the server **104** determines which resources of which client device or storage device to allocate for use in performing a subscription computing service identified in the subscription computing information, as well as when the subscription computing service is to be performed using this resource.

With the present invention, a customer subscribes to a particular set of subscription computing services provided by a subscription computing service provider. The subscription computing services to which a customer subscribes is preferably stored in a database for use in determining what services to provide to the customer (hereafter referred to as a subscriber) at a later time. The subscription computing services may be, for example, backing up data on a subscriber computing platform, performing a computationally intensive operation, such as data mining or data analysis, or the like. The subscription computing services require computing resources in order for the services to be performed, e.g., data storage resources, processor resources, and the like.

The subscription computing service provider determines when sufficient resources are available from other subscriber computing platforms to perform these subscription computing services. In addition, the subscription computing service provider allocates these resources to perform the subscription computing services and maintains information about which resources are being utilized for which subscription computing services.

In one embodiment, a subscription computing service provider workstation is provided through which a human operator may issue commands to initiate a subscription computing service using subscriber computing platform resources. For example, the human operator may determine that it is time to backup data from client device **108**. The human operator may enter a command into the subscription computing service provider workstation causing the subscription computing service provider to interrogate the other subscriber computing platforms, i.e. client devices **110, 112** and storage device **106**, to determine which of the client devices **110, 112** and storage device **106** have sufficient free storage area to store the data from client device **108**.

As mentioned above, the client devices **110, 112** and storage device **106** are preferably equipped with a reporting device that, upon receiving a request from the subscription computing service provider, provides system operating information of the particular client device **110, 112** and storage device **106** with which they are associated. The system operating information may include, for example, an amount of free data storage area, an amount of CPU usage, and the like. The Windows 2000 operating system (and other versions of Windows) supports an interface called the Windows Management Interface (WMI) from which the system operating information may be obtained, for example.

This system operating information is received by the subscription computing service provider and analyzed to determine which of the client devices **110, 112** and storage device **106** have sufficient resources to handle the subscription computing service. In this particular example, a determination is made as to which of the client devices **110, 112** and storage device **106** have sufficient data storage area to store the

backup data from the client device **108**. If, for example, client device **110** has sufficient data storage area, the subscription computing service provider may allocate enough of the free data storage area of the client device **110** for storage of the backup data from client device **108**.

This allocation of free data storage area on client device **110** may be performed in a transparent manner with respect to a user of the client device **110**. That is, data may be read from the client device **108** and written to a hidden partition of the client device **110** that is not viewable by the user of the client device **110**. This backup data is maintained in the hidden partition as long as necessary, i.e. until overwritten by newer backup data, or until the storage area reserved in the hidden partition is needed by the client device **110** itself. In the event that the client device **110** needs the storage area reserved to the hidden partition, the data stored in the hidden partition may be migrated to another client device in the subscriber's enterprise or to a storage device associated with the subscription computing services provider.

While the above example assumes that one of the client devices **110, 112** or the storage device **106** will have sufficient data storage area to store all of the backup data from the client device **108**, this may not be the case. Therefore, if none of the client devices **110, 112** and storage device **106** have sufficient free data storage area for storing all of the backup data for client device **108**, the backup data may be distributed across a plurality of the storage devices of the client devices **110, 112** and storage device **106**. Thus, a first number of backup files may be stored on client device **110**, a second number of backup files may be stored on client device **112**, and a third number of backup files may be stored on storage device **106** in hidden partitions, for example.

The subscription computing services provider maintains information for identifying which resources have been allocated for which subscription computing services. Thus, for example, the subscription computing services provider will maintain information identifying what data was backed-up to which partition of which client device **110, 112** or storage device **106**. For example, the subscription computing services provider may maintain a record in storage indicating that files 1-100 were backed-up to client device **110** at partition H, addresses locations 1-100 on February

16, 2001. This information is preferably updated as it changes due to the performance of other subscription computing services, e.g., a subsequent backup of the data files.

In addition to data storage services, the subscription computing services provider may provide processor based subscription computing services, such as data analysis, data mining, running of applications, and the like. With processor based subscription computing services, like with the data storage and backup example provided above, a request may be sent from the subscription computing services provider to the client devices **108**, **110** and **112**, for system operating information. The system operating information may identify whether one or more processors associated with the client devices **108**, **110** and **112** is being underutilized, i.e. has spare computation cycles. If it is determined that the client device **108**, for example, has spare computation cycles, the subscription computing services provider may instruct the client device **108** to perform a computation in support of a subscription computing service. For example, the subscription computing services provider may instruct the client device **108** to analyze a particular chunk of data and return a result.

In an alternative embodiment, rather than requiring a human operator to initiate the performance of subscription computing services, the present invention may be performed in an automatic manner. That is, the subscription computing services provider may determine that a particular subscription computing service must be performed at a particular time based on a service agreement between the subscription computing service provider and the subscriber. Based on this service agreement, the subscription computing services provider automatically issues a request to the client devices **108**, **110** and **112**, and storage device **106** to acquire system operating information and the operation proceeds as described above. In this way, the need for a human operator is eliminated.

Moreover, the subscription computing services provider of the present invention may constantly monitor the various client devices **108**, **110**, and **112**, and storage device **106** to determine if resources become available that may be used by the subscription computing services provider to perform subscription computing services. By constant monitoring, what is meant is that requests are periodically broadcast to the

subscriber's computing platforms and the system operating information returned is analyzed to determine if spare resources are available for use by the subscription computing services provider. In this way, subscription computing services may be performed using resources of the subscriber's computing platforms when these resources are being underutilized.

Referring to **Figure 2**, a block diagram of a data processing system that may be implemented as a server, such as server **104** in **Figure 1**, is depicted in accordance with a preferred embodiment of the present invention. Data processing system **200** may be a symmetric multiprocessor (SMP) system including a plurality of processors **202** and **204** connected to system bus **206**. Alternatively, a single processor system may be employed. Also connected to system bus **206** is memory controller/cache **208**, which provides an interface to local memory **209**. I/O bus bridge **210** is connected to system bus **206** and provides an interface to I/O bus **212**. Memory controller/cache **208** and I/O bus bridge **210** may be integrated as depicted.

Peripheral component interconnect (PCI) bus bridge **214** connected to I/O bus **212** provides an interface to PCI local bus **216**. A number of modems may be connected to PCI local bus **216**. Typical PCI bus implementations will support four PCI expansion slots or add-in connectors. Communications links to network computers **108-112** in **Figure 1** may be provided through modem **218** and network adapter **220** connected to PCI local bus **216** through add-in boards.

Additional PCI bus bridges **222** and **224** provide interfaces for additional PCI local buses **226** and **228**, from which additional modems or network adapters may be supported. In this manner, data processing system **200** allows connections to multiple network computers. A memory-mapped graphics adapter **230** and hard disk **232** may also be connected to I/O bus **212** as depicted, either directly or indirectly.

Those of ordinary skill in the art will appreciate that the hardware depicted in **Figure 2** may vary. For example, other peripheral devices, such as optical disk drives and the like, also may be used in addition to or in place of the hardware depicted. The depicted example is not meant to imply architectural limitations with respect to the present invention. The data processing system depicted in **Figure 2** may be, for

example, an IBM e-Server pSeries system, a product of International Business Machines Corporation in Armonk, New York, running the Advanced Interactive Executive (AIX) operating system or LINUX operating system.

With reference now to **Figure 3**, a block diagram illustrating a data processing system is depicted in which the present invention may be implemented. Data processing system **300** is an example of a client computer, such as client devices **108**, **110** and **112** in **Figure 1**. Data processing system **300** employs a peripheral component interconnect (PCI) local bus architecture. Although the depicted example employs a PCI bus, other bus architectures such as Accelerated Graphics Port (AGP) and Industry Standard Architecture (ISA) may be used. Processor **302** and main memory **304** are connected to PCI local bus **306** through PCI bridge **308**. PCI bridge **308** also may include an integrated memory controller and cache memory for processor **302**. Additional connections to PCI local bus **306** may be made through direct component interconnection or through add-in boards. In the depicted example, local area network (LAN) adapter **310**, SCSI host bus adapter **312**, and expansion bus interface **314** are connected to PCI local bus **306** by direct component connection. In contrast, audio adapter **316**, graphics adapter **318**, and audio/video adapter **319** are connected to PCI local bus **306** by add-in boards inserted into expansion slots. Expansion bus interface **314** provides a connection for a keyboard and mouse adapter **320**, modem **322**, and additional memory **324**. Small computer system interface (SCSI) host bus adapter **312** provides a connection for hard disk drive **326**, tape drive **328**, and CD-ROM drive **330**. Typical PCI local bus implementations will support three or four PCI expansion slots or add-in connectors.

An operating system runs on processor **302** and is used to coordinate and provide control of various components within data processing system **300** in **Figure 3**. The operating system may be a commercially available operating system, such as Windows 2000, which is available from Microsoft Corporation. An object oriented programming system such as Java may run in conjunction with the operating system and provide calls to the operating system from Java programs or applications executing on data processing system **300**. "Java" is a trademark of Sun Microsystems, Inc.

Instructions for the operating system, the object-oriented operating system, and applications or programs are located on storage devices, such as hard disk drive **326**, and may be loaded into main memory **304** for execution by processor **302.**

Those of ordinary skill in the art will appreciate that the hardware in **Figure 3** may vary depending on the implementation. Other internal hardware or peripheral devices, such as flash ROM (or equivalent nonvolatile memory) or optical disk drives and the like, may be used in addition to or in place of the hardware depicted in **Figure 3**. Also, the processes of the present invention may be applied to a multiprocessor data processing system.

As another example, data processing system **300** may be a stand-alone system configured to be bootable without relying on some type of network communication interface, whether or not data processing system **300** comprises some type of network communication interface. As a further example, data processing system **300** may be a Personal Digital Assistant (PDA) device, which is configured with ROM and/or flash ROM in order to provide non-volatile memory for storing operating system files and/or user-generated data.

The depicted example in **Figure 3** and above-described examples are not meant to imply architectural limitations. For example, data processing system **300** also may be a notebook computer or hand held computer in addition to taking the form of a PDA. Data processing system **300** also may be a kiosk or a Web appliance.

The present invention provides a subscription computing service apparatus, system and method in which the subscription computing service is performed using resources of the subscriber computing platforms in a peer-to-peer manner. Thus, the work and resources necessary to provide the subscription computing service is distributed among the computing devices and storage devices of the subscriber's system(s) and/or network. The peer-to-peer subscription computing services are controlled by a subscription computing services provider which allocates resources of the subscriber computing platforms to various subscription computing services as well as determines when to perform the subscription computing services. The allocation of resources and determination of when to perform the computing services

may be based on system operating information reported back to the subscription computing services provider by the subscriber's computing platforms, for example.

Figure 4 is an exemplary block diagram of the primary operation components of a subscription computing services provider in accordance with the present invention. The elements shown in **Figure 4** may be implemented in software, hardware, or a combination of software and hardware. In a preferred embodiment, the elements of **Figure 4** are implemented as software instructions executed in hardware elements, such as processor **202** or **204**, network adapter **220**, memory controller/cache **208**, and the like.

As shown in **Figure 4**, the subscription computing services provider **400** includes a subscription computing services provider controller **410** (hereafter the controller **410**), a service provider operator workstation interface **420**, a network interface **430**, a subscription services database **440**, a control program memory **450**, and a subscription computing services data storage **460**. The elements **410-460** are coupled to one another via the control/data bus **470** through which control signals and data signals may be routed to various ones of the elements **410-460**. Although a bus architecture is shown in **Figure 4**, the present invention is not limited to any particular architecture. Rather, any type of architecture the permits the communication of control signals and data signals to the elements **410-460** may be used without departing from the spirit and scope of the present invention.

The controller **410** controls all of the operations of the subscription computing services provider based on control programs stored in the control program memory **450**. The controller **410** sends requests for system operating information to client devices of a subscriber's enterprise via the network interface **430**. These requests may be sent based on an automatic operation of the controller **410** or may be based on instructions received from a human operator via the service provider operator workstation interface **420**.

The controller **410** receives responses to the requests from the various client devices via the network interface **430** and analyzes the responses to determine which of the client devices have spare resources that may be used to perform subscription

computing services for the subscriber. The determination of which subscription computing services are to be provided to the subscriber may be determined, for example, based on service agreement information maintained in the subscription services database **440**. In addition, the subscription services database **440** may further store actual programs and/or instructions for initiating the subscription computing services on the client devices. Alternatively, these programs and/or instructions may be part of the control programs stored in the control program memory **450**.

Based on the analysis of the responses received and the subscription computing services subscribed to by the subscriber, the controller **410** allocates resources on the various client devices for use in providing the subscription computing services. A record of the allocation of resources is stored in the subscription computing services data storage **460** along with any other necessary information to manage the resources used by the subscription computing services. The controller **410** then instructs the client devices to perform the desired functions of the subscription computing service, such as read data, write data, process data, and the like.

Figure 5 is an exemplary diagram illustrating an example implementation of the present invention. As shown in **Figure 5**, two subscriber office workstations **520** and **530** are linked to one another and a subscription computing service provider **540** via a network **510** and links x, y and z, respectively. Link x connects subscriber office 1 workstation **520** with subscriber office 2 workstation **530**, link y connects subscriber office 1 workstation **520** with subscription computing service provider **540**, and link z connects subscriber office 2 workstation **530** with the subscription computing service provider **540**. All of the links x, y, and z may be separate links or may be logical links sharing a common carrier, such as the Internet, for example.

Each of the subscriber office workstations **520** and **530** have associated data storage devices **525** and **535**. In addition, a service provider operator workstation **550** may be provided in association with the subscription computing service provider **540**. While a service provider operator workstation **550** is shown in this particular example, as mentioned above, a human operator is not necessary to the operation of

the present invention and the present invention may be implemented in a fully automatic manner without departing from the spirit and scope of the present invention.

Assume that the subscription computing service that is to be provided is the backup of user data from the data storage device **525** of the subscriber office workstation **520**. In one embodiment, the human operator at the service provider operator workstation **550** may initiate the backup by issuing a command via a user interface to the facilities of the subscription computing service provider **540**. In an alternative embodiment, the subscription computing service provider **540** may initiate the backup service automatically.

In response to determining that a subscription computing service is to be performed on the data storage device **525** of the subscriber office workstation **520**, the subscription computing service provider **540** signals over links y and z to the subscriber office workstations **520** and **530**. The signals are received in peer-to-peer platform components associated with the subscriber office workstations **520** and **530** which report back to the subscription computing service provider **540** that there is sufficient disk storage space to backup the data from the data storage device **525** to the data storage device **535**.

Having discovered sufficient storage space to perform the backup subscription computing service, the subscription computing service provider **540** instructs a backup service to read data from the data storage device **525** and write that data to the data storage device **535**. The backup service is a script that executes a series of actions such as identifying files changed since a last backup, forming a list of these files, sequencing through the list and copying each file from its source to its destination, and marking each file as backed up. This service is normally provided on the client devices themselves but may be provided on a local or remote server. The backup data may be written to a hidden partition of the data storage device **535** that is not visible to the user of the client device **530**.

Note that this distributed backup is secure because it uses facilities managed by the subscription computing service provider and within the physical control of the

subscriber's enterprise. The present invention, however, is not limited to performing subscription computing services only within the subscriber's enterprise. The present invention may be used across subscriber enterprises such that, for example, data on a subscriber workstation in a first subscriber enterprise is backed up to a storage device in a second subscriber enterprise. In such a case, the data may be encrypted before it is stored or used by the subscriber workstations of the other subscriber enterprise. In this way, the security of the data may be maintained.

Figure 6 is a flowchart outlining an exemplary operation of the present invention. As shown in **Figure 6**, the operation starts with initiation of a subscription subscriber service (step **610**). As mentioned above, this may be in response to a human operator instruction or an automatic determination that it is time to perform a subscription subscriber service.

A request is sent to the subscriber enterprise devices requesting system operating information (step **620**). Responses are received and analyzed (step **630**). A determination is made as to whether one or more of the subscriber enterprise devices, either alone or in combination, provide sufficient spare resources to perform the subscription subscriber service (step **640**). If not, an error may be logged (step **650**) and the operation ends.

If sufficient resources are present, the operation allocates the resources and stores a record of the allocation (step **660**). Thereafter, instructions are issued to the subscriber enterprise devices instructing them to perform the necessary operations to perform the subscription computing service (step **670**). The operation then ends.

Thus, the present invention provides an apparatus, system and method for providing subscription computing services using spare resources of subscriber computing devices. The present invention eliminates the need for the subscription computing services provider to maintain resources to provide the various subscription computing services and offloads this requirement by distributing the performance of the subscription computing services to the subscriber computing devices themselves. By reducing the amount of resources that must be maintained by the provider, the overall cost of the subscription computing services to the subscriber may be reduced.

While the present invention has been described in terms of using the resources of a client device to perform subscription computing services, the present invention is not limited to such. Rather, the client devices may be equipped with extra resources, or the subscriber enterprise may be equipped with extra resources, that are explicitly used as a mechanism to provide spare resources for subscription computing services. For example, a subscriber workstation may be equipped with a spare hard drive, processor, or the like, that is used exclusively or primarily for providing subscription computing services.

In addition, while the present invention has been described in terms of providing data services (e.g., data backup) and computational services (e.g., data analysis), the present invention may be used to perform other types of subscription computing services without departing from the spirit and scope of the present invention. For example, the present invention may be used to perform business computations when subscriber resources are being underutilized. Any type of subscription computing service is intended to be within the spirit and scope of the present invention.

It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in the form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media, such as a floppy disk, a hard disk drive, a RAM, CD-ROMs, DVD-ROMs, and transmission-type media, such as digital and analog communications links, wired or wireless communications links using transmission forms, such as, for example, radio frequency and light wave transmissions. The computer readable media may take the form of coded formats that are decoded for actual use in a particular data processing system.

The description of the present invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the

invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiments were chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.